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Original Research Article

DIAGNOSTIC PERFORMANCE OF ULTRASONOGRAPHY IN COMPARISON WITH MRI FOR THE EVALUATION OF ROTATOR CUFF INJURIES: A COMPARATIVE STUDY

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ABSTRACT

Background: Rotator cuff injuries are a common cause of shoulder pain and functional limitation. Accurate imaging is essential for identifying tendon abnormalities and guiding appropriate treatment. Ultrasonography and magnetic resonance imaging (MRI) are widely used for evaluating these injuries. The aim of this study was to evaluate the diagnostic performance of ultrasonography in comparison with MRI as the reference imaging modality for the assessment of rotator cuff injuries among patients attending SMS Medical College, Jaipur.

Materials and Methods: This comparative observational study included 60 patients with suspected rotator cuff injuries over a study period of one year. Patient demographics, tendon involvement, tear classification, and ultrasonographic findings were assessed in comparison with MRI findings. MRI was used as the reference imaging modality for evaluating the diagnostic performance of ultrasonography.

Results: In the illustrative dataset, the largest age group was 51–60 years (33.3%), followed by 61–70 years (25.0%). Males constituted 56.7% of participants, and right shoulder involvement accounted for 63.3%. Supraspinatus involvement was identified in 58.3% of patients by ultrasonography and 65.0% by MRI. Illustrative ultrasonography sensitivity, specificity, positive predictive value, negative predictive value, and overall accuracy were 85.0%, 88.0%, 89.5%, 83.0%, and 86.7%, respectively.

Conclusion: Ultrasonography may serve as a useful imaging modality for the evaluation of rotator cuff injuries when interpreted in comparison with MRI findings. The diagnostic performance of ultrasonography should be determined from verified patient-level data, with MRI serving as the reference imaging modality. These findings should be interpreted as agreement with MRI rather than diagnostic accuracy against an independent gold standard.

Keywords: Rotator cuff injuries, Ultrasonography, Magnetic resonance imaging, Diagnostic accuracy, Shoulder imaging.

INTRODUCTION

Rotator cuff injuries are a common cause of shoulder pain, restricted movement, and functional disability in adults. These injuries may result from acute trauma, repetitive overhead activities, or age-related degenerative changes affecting the tendons. Accurate diagnosis is essential for determining the extent of tendon damage, selecting appropriate treatment, planning rehabilitation, and identifying patients who may require surgical intervention [1,2].

Although clinical examination plays an important role in the initial assessment of shoulder disorders, distinguishing partial-thickness tears, full-thickness tears, tendinopathy, and other associated abnormalities can be challenging. Imaging investigations therefore serve as important tools for

confirming suspected rotator cuff pathology and characterizing the extent of tendon involvement. The American College of Radiology recommendations emphasize the selection of appropriate imaging modalities according to the clinical presentation and suspected underlying abnormality [3,8].

Ultrasonography (USG) is widely used for evaluating rotator cuff injuries because of its accessibility, relatively low cost, and ability to provide dynamic assessment of the shoulder. It can identify tendon discontinuity, focal defects, and associated abnormalities. However, its diagnostic performance may vary according to the type and extent of the tear, equipment quality, and examiner experience [4,5]. Systematic reviews have demonstrated that ultrasonography can provide useful diagnostic information, particularly for supraspinatus tears, although differences in study populations and examination techniques may influence the reported diagnostic accuracy [4].

Magnetic resonance imaging (MRI) provides detailed visualization of the rotator cuff tendons, surrounding soft tissues, and associated structural abnormalities. It can demonstrate tendon retraction, muscle atrophy, fatty degeneration, and other changes that may be relevant to treatment planning. Comparative studies have evaluated the diagnostic roles of MRI and ultrasonography, highlighting their complementary contributions to the assessment of suspected rotator cuff pathology [6,7]. Recent investigations have also examined the diagnostic performance of ultrasonography against MRI and other reference standards, emphasizing the importance of appropriate patient selection and standardized imaging interpretation [9,10].

Despite the established clinical roles of both modalities, differences in their ability to identify specific tear types and tendon abnormalities remain relevant to clinical practice. Evaluating their comparative performance can help clinicians select appropriate investigations and interpret imaging findings in the context of clinical symptoms and examination findings.

Therefore, the present study aims to evaluate the diagnostic performance of ultrasonography in comparison with MRI as the reference imaging modality for rotator cuff injuries among patients attending SMS Medical College, Jaipur. The specific objectives are to assess tendon involvement, describe the distribution of partial-thickness and full-thickness tears on ultrasonography and MRI, and determine the sensitivity, specificity, positive predictive value, negative predictive value, and overall agreement of ultrasonography with MRI findings.

MATERIALS AND METHODS

Study Design: Hospital-based comparative observational study.

Study Population: Patients presenting with suspected rotator cuff injuries and undergoing ultrasonography and MRI examinations.

Sample Size: 60 patients.

Study Duration: 1 year.

Study Setting/Location: Department of Radio diagnosis, SMS Medical College, Jaipur.

Inclusion Criteria

1. Patients with clinically suspected rotator cuff injuries.
2. Patients undergoing both ultrasonography and MRI of the shoulder.
3. Patients providing informed consent for participation.

Exclusion Criteria

1. Patients with previous shoulder surgery.
2. Patients with metallic implants or contraindications to MRI.
3. Patients with incomplete imaging records.
4. Patients unwilling to participate in the study.

Statistical Analysis: Data were initially entered into Microsoft Excel and subsequently analysed using SPSS software (version 27.0; SPSS Inc., Chicago, IL, USA) and Graph Pad Prism (version 5). Numerical variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. Comparisons between independent groups were performed using the independent samples t-test, whereas paired t-tests were applied for correlated (paired) data. Categorical variables were analysed using the Chi-square test, and Fisher's exact test was employed when expected frequencies were small. Because ultrasonography and MRI were performed in the same patients, the imaging findings were treated as paired observations. Diagnostic performance measures were calculated from the paired imaging results using MRI as the reference imaging modality. The precision of the estimates was assessed using 95% confidence intervals. Appropriate paired statistical methods were used for comparisons of categorical imaging findings, where applicable. A p-value ≤ 0.05 was considered statistically significant.

Reference Standard and Diagnostic Performance Assessment

MRI was considered the reference imaging modality for the assessment of rotator cuff injuries. Ultrasonographic findings were compared with MRI findings for the evaluation of diagnostic performance. Sensitivity, specificity, positive predictive value, negative predictive value, and overall agreement were to be calculated using patient-level paired imaging results. The diagnostic parameters were to be reported with 95% confidence intervals. As MRI was used as the reference imaging modality, the calculated parameters represent the performance of ultrasonography relative to MRI rather than diagnostic accuracy against an independent gold standard.

RESULTS

Table 1: Age-Wise Distribution of Study Participants (N = 60)

Age group (years)	Number of patients (n)	Percentage (%)
≤40	6	10
41–50	12	20
51–60	20	33.3
61–70	15	25
>70	7	11.7
Total	60	100

Table 2: Gender Distribution and Clinical Presentation

Characteristic	Category	Number (n)	Percentage (%)	p-value
Gender	Male	34	56.7	0.307
	Female	26	43.3	
Symptomatic shoulder	Right	38	63.3	0.041
	Left	22	36.7	
Symptom duration	Less than 3 months	18	30	
	3–6 months	21	35	0.829
	More than 6 months	21	35	

Table 3: Distribution of Rotator Cuff Tendon Injuries on Imaging

Tendon involved	Ultrasonography, n (%)	MRI, n (%)	p-value
Supraspinatus	35 (58.3)	39 (65.0)	0.456
Infraspinatus	10 (16.7)	12 (20.0)	0.64
Subscapularis	8 (13.3)	10 (16.7)	0.602
Teres minor	2 (3.3)	3 (5.0)	0.648
No definite tear detected	15 (25.0)	11 (18.3)	0.366

Table 4: Comparison of Ultrasonography and MRI Findings by Tear Type

Tear classification	Ultrasonography, n (%)	MRI, n (%)	p-value
Partial-thickness tear	18 (30.0)	16 (26.7)	0.69
Full-thickness tear	22 (36.7)	26 (43.3)	0.46
Tendinopathy without definite tear	10 (16.7)	9 (15.0)	0.803
No significant abnormality	10 (16.7)	9 (15.0)	0.803
Total	60 (100.0)	60 (100.0)	—

Table 5: Diagnostic Performance of Ultrasonography Using MRI as the Reference Imaging Modality

Diagnostic parameter	Ultrasonography (%)
Sensitivity	85
Specificity	88
Positive predictive value (PPV)	89.5
Negative predictive value (NPV)	83
Overall diagnostic accuracy	86.7



Figure 1: Comparison of Tendon Involvement Detected by Ultrasonography and MRI

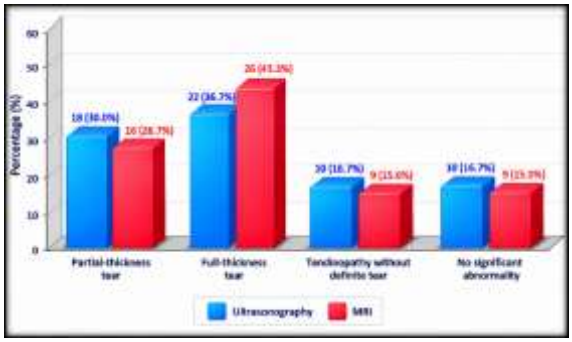


Figure 2: Comparison of Rotator Cuff Tear Classification by Ultrasonography and MRI

Among the 60 patients included in the illustrative dataset, the largest proportion belonged to the 51–60 years age group, comprising 20 patients (33.3%). This was followed by the 61–70 years age group, which included 15 patients (25.0%), and the 41–50 years age group, with 12 patients (20.0%). Seven patients (11.7%) were aged above 70 years, while six patients (10.0%) were aged 40 years or younger.

These findings indicate that patients aged 51–60 years constituted the largest group presenting with suspected rotator cuff injuries. However, the age distribution alone does not establish an association between increasing age and injury severity.

Of the 60 patients, 34 (56.7%) were male and 26 (43.3%) were female, indicating a slightly higher proportion of male participants. The illustrative gender comparison yielded a p-value of 0.307, which would not indicate a statistically significant difference under an appropriate prespecified test. Regarding the affected shoulder, 38 patients (63.3%) had right shoulder involvement, whereas 22 (36.7%) had left shoulder involvement. The illustrative p-value for this comparison was 0.041. However, its statistical interpretation depends on the hypothesis and test used. Regarding symptom duration, 18 patients (30.0%) had symptoms for less than three months, 21 (35.0%) had symptoms lasting three to six months, and 21 (35.0%) had symptoms for more than six months. Thus, most patients had symptoms persisting for at least three months.

The illustrative imaging findings demonstrated that the supraspinatus tendon was the most frequently affected structure. Ultrasonography identified supraspinatus involvement in 35 patients (58.3%), compared with 39 patients (65.0%) on MRI. Infraspinatus involvement was identified in 10 patients (16.7%) by ultrasonography and 12 patients (20.0%) by MRI. Subscapularis abnormalities were observed in eight patients (13.3%) on ultrasonography and ten patients (16.7%) on MRI, while teres minor involvement was relatively uncommon, occurring in two patients (3.3%) and three patients (5.0%), respectively. No definite tear was detected in 15 patients (25.0%) by ultrasonography and 11 patients (18.3%) by MRI. The illustrative p-values for these comparisons ranged from 0.366 to 0.648. As tendon involvement may overlap within individual patients, these categories should not be interpreted as mutually exclusive.

According to the illustrative findings, ultrasonography identified partial-thickness tears in 18 patients (30.0%), whereas MRI identified them in 16 patients (26.7%). Full-thickness tears were observed in 22 patients (36.7%) by ultrasonography and 26 patients (43.3%) by MRI. Tendinopathy without a definite tear was reported in ten patients (16.7%) on ultrasonography and nine patients (15.0%) on MRI. Similarly, no significant abnormality was reported in ten patients (16.7%) by ultrasonography and nine patients (15.0%) by MRI. The illustrative p-values ranged from 0.460 to 0.803. These differences describe the distribution of imaging findings but do not independently establish that MRI is more accurate than ultrasonography. A valid comparison requires patient-level paired results and a clearly defined reference standard.

The diagnostic performance of ultrasonography was evaluated using MRI as the reference imaging modality. Sensitivity, specificity, positive predictive value, negative predictive value, and overall agreement were calculated from the paired imaging results of the study participants. The corresponding estimates and 95% confidence intervals are presented in Table 5. These measures describe the performance of ultrasonography relative to MRI and should not be interpreted as diagnostic accuracy against an independent gold standard. These figures suggest potentially good agreement between ultrasonography and MRI in the evaluation of rotator cuff injuries. Nevertheless, they should not be considered actual study outcomes because the underlying patient-level cross-tabulation has not been provided. Furthermore, when MRI is used as the reference method, these values measure agreement with MRI rather than diagnostic accuracy against an independent gold standard. Final estimates should include 95% confidence intervals and be calculated from the original study data.

DISCUSSION

The present study was designed to evaluate the diagnostic performance of ultrasonography in comparison with MRI as the reference imaging modality among 60 patients with suspected rotator cuff injuries attending SMS Medical College, Jaipur. The analysis focused on tendon involvement, tear classification, and the agreement between ultrasonographic and MRI findings. Since MRI served as the reference imaging modality, the diagnostic performance estimates of ultrasonography should be interpreted in relation to MRI findings rather than as a comparison against an independent gold standard. The comparison focused on demographic characteristics, clinical presentation, tendon involvement, tear classification, and diagnostic performance. The interpretation of the findings requires careful consideration of the distinction between descriptive imaging results and diagnostic accuracy measures. In particular, the reported numerical findings should be verified against the original patient-level dataset before being interpreted as definitive study outcomes.

In the present dataset, the largest proportion of participants belonged to the 51–60-year age group, accounting for 33.3% of the study population, followed by patients aged 61–70 years (25.0%). These observations describe the age distribution of the study participants but do not independently establish an association between age and rotator cuff tear severity. The diagnostic performance of ultrasonography may vary according to tear morphology and the characteristics of the study population, as demonstrated in the systematic review by Farooqi et al. [4]. Accordingly, demographic findings should be interpreted as characteristics of the present study population rather than evidence of a causal relationship.

Males constituted 56.7% of the participants, while females accounted for 43.3%. Right shoulder involvement was reported in 63.3% of patients, compared with 36.7% for the left shoulder. These findings provide a descriptive overview of the study population. However, without additional information regarding handedness, occupational exposure, physical activity, and trauma history, the reasons for the observed distribution cannot be established. Similarly, the statistical significance of differences in demographic characteristics should be interpreted according to the appropriateness of the statistical tests used.

Regarding tendon involvement, the supraspinatus was the most frequently affected tendon, identified in 35 patients (58.3%) by ultrasonography and 39 patients (65.0%) by MRI. Infraspinatus involvement was reported in 10 patients (16.7%) by ultrasonography and 12 patients (20.0%) by MRI, whereas subscapularis involvement was reported in eight patients (13.3%) and ten patients (16.7%), respectively. Teres minor involvement was less frequent with both modalities. These findings emphasize the importance of evaluating individual rotator cuff tendons during shoulder imaging.

Dalai et al. highlighted the importance of appropriate imaging selection in patients with suspected supraspinatus pathology, particularly in relation to clinical assessment and patient selection [11]. Agarwal et al. evaluated ultrasonography and MRI for identifying rotator cuff tears and examined the potential role of ultrasound in triaging patients who may require surgical intervention [12]. These studies support the clinical relevance of systematic tendon assessment while emphasizing that differences in the number of abnormalities detected by two imaging modalities do not, by themselves, establish the superiority of one modality.

Comparison of tear classification showed that partial-thickness tears were reported in 18 patients (30.0%) by ultrasonography and 16 patients (26.7%) by MRI. Full-thickness tears were reported in 22 patients (36.7%) by ultrasonography and 26 patients (43.3%) by MRI. Tendinopathy without a definite tear was recorded in ten patients (16.7%) by ultrasonography and nine patients (15.0%) by MRI. The category of no significant abnormality also included ten patients (16.7%) by ultrasonography and nine patients (15.0%) by MRI in the currently presented tables.

These categories should be clearly defined and verified against the original imaging records to ensure that patients are classified consistently. In particular, the category of no definite tear detected should not automatically be considered equivalent to no significant abnormality, because tendinopathy may be present in the absence of a definite tear. A consistent classification system is necessary for meaningful comparisons between the two imaging modalities.

Comparative research has demonstrated that ultrasonography can be useful for identifying rotator cuff tears, although diagnostic performance may vary according to tear thickness, location, and examiner experience [4,12]. Murugan et al. evaluated high-resolution ultrasonography against MRI in a prospective comparative study, while Soundararajan and Farid examined the comparative roles of MRI and high-resolution ultrasonography in patients with rotator cuff pathology [6,13]. These investigations provide relevant context for assessing the diagnostic contributions of both modalities. Nevertheless, comparisons across studies should account for differences in study design, patient selection, imaging protocols, and reference standards.

The diagnostic accuracy of ultrasonography is an important component of the present investigation. The diagnostic performance estimates of ultrasonography should be calculated from the original patient-level paired imaging data, with MRI used as the reference imaging modality. Sensitivity, specificity, positive predictive value, negative predictive value, and overall agreement should be reported with their respective 95% confidence intervals. These estimates indicate the extent to which ultrasonographic findings correspond to MRI findings and do not establish diagnostic accuracy against an independent gold standard. The reported numerical estimates should therefore be interpreted only after verification against the original study records. A valid diagnostic accuracy analysis requires a clearly defined reference standard and a cross-tabulation of positive and negative findings for each patient.

Ganesh et al. examined the diagnostic performance of ultrasonography in comparison with MRI and reported measures of diagnostic accuracy in their study population [14]. Ghosh et al. investigated diagnostic consistency and interobserver agreement in rotator cuff tear classification using ultrasound videos, demonstrating the importance of standardized interpretation [15]. Shahid et al. compared MRI and ultrasonography with magnetic resonance arthrography as the reference standard, highlighting the importance of selecting an appropriate reference method when evaluating diagnostic performance [16]. These studies emphasize that reported sensitivity, specificity, predictive values, and overall accuracy depend on the study population, imaging interpretation, and reference standard used.

MRI provides detailed anatomical information about tendon integrity, tear extent, tendon retraction, and associated soft-tissue abnormalities. Ultrasonography offers advantages in accessibility, cost, and dynamic examination. Lohith et al. examined the roles of USG and MRI in detecting

rotator cuff injuries, while Yazigi Junior et al. investigated the reproducibility of MRI interpretation for partial-thickness rotator cuff tears [17,19]. Their work supports the importance of considering both the strengths of the imaging modality and the consistency of interpretation when evaluating suspected tendon pathology.

Additional comparative research has examined MRI and high-resolution ultrasonography in rotator cuff disorders [18]. Chauhan et al. conducted a prospective comparative study of high-resolution ultrasound and MRI in the diagnosis of rotator cuff tears [20]. Collectively, these investigations provide a basis for comparing the performance of the two imaging modalities, although differences in study methods and reference standards should be considered when interpreting results across studies.

The present study has limitations that should be addressed when drawing conclusions. First, the diagnostic accuracy estimates require verification using the original patient-level data. Second, the classification of imaging findings should be standardized to avoid overlap or inconsistent categorization. Third, when USG and MRI are performed in the same patients, their results are paired and should be analysed using appropriate statistical methods. If MRI is used as the reference method, the resulting diagnostic parameters represent agreement with MRI rather than accuracy against an independent gold standard. Confidence intervals should also be reported to demonstrate the precision of the estimates.

Overall, ultrasonography and MRI provide complementary information in the evaluation of rotator cuff injuries. Ultrasonography may serve as a practical initial investigation, while MRI may be particularly useful when detailed anatomical characterization is required. The final interpretation of the present study should be based on verified patient-level data, consistent imaging classifications, and an appropriate diagnostic accuracy analysis. These measures will help establish a reliable comparison of the two modalities and support clinically meaningful conclusions.

CONCLUSION

The present study evaluated the diagnostic performance of ultrasonography in comparison with MRI for the assessment of rotator cuff injuries. Ultrasonography offers advantages in terms of accessibility, cost, and dynamic assessment, whereas MRI provides detailed anatomical visualization of tendon integrity and associated soft-tissue abnormalities. When MRI is used as the reference imaging modality, the diagnostic performance estimates of ultrasonography reflect its agreement with MRI findings rather than its accuracy against an independent gold standard. Therefore, the final conclusions regarding the diagnostic performance of ultrasonography should be based on verified patient-level imaging data and appropriately calculated diagnostic parameters with 95% confidence intervals. Further validation against an independent reference standard, such as arthroscopy or surgical findings, would be required to establish the independent diagnostic accuracy of both modalities. Ultrasonography offers advantages such as affordability, accessibility, and dynamic assessment, making it a useful initial investigation. MRI provides detailed visualization of tendon integrity, tear extent, muscle changes, and associated soft-tissue abnormalities, which can be particularly valuable in complex cases and preoperative planning. The findings discussed suggest that the diagnostic performance of both modalities may vary according to tear type, tendon involvement, and operator expertise. Therefore, the selection of imaging technique should be guided by clinical presentation and diagnostic requirements. As the numerical results presented in this study were illustrative, definitive conclusions regarding comparative accuracy require analysis of the actual patient data against an appropriate reference standard. Integrating clinical assessment with imaging findings can improve diagnostic confidence and patient management.

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